B15. P4

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technical handbook

MODEL TCW-250

SECTION 1

INTRODUCTION

The regulated power supply unit type TCU-250 is a fully tabilized unit, from which an output of up to 50V can be obtained t a maximum load current of 2A. The output voltage is fully ariable over the range 0-50V and complete overload protection s provided.

The unit is housed in a light brown steel case with a light rey front panel on which are mounted a dual-scale meter, utput terminals, and all controls. The mains cable entry is ia a 3-pin plug situated at the rear of the unit.

The TCU-250 is one of a 'family' of stabilized power units, he others of which are:- TCU-150, 1A; TCU-550 50V, 5A and CU-1050 50V, 10A.

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SECTION 2

SPECIFICATION

ains input	200-250V a.c. 45-65 Hz, single phase
utput current	2A maximum.
utput voltage	0-50V d.c. in five switched steps with continuous control over a 10V range at each step.
pple and noise	Less than 1 mV peak-to-peak (Typically 250 μV peak-to-peak)
tput resistance (d.c.)	Not greater than 0.01 ohm. (Typically 0.004 ohm)
tput impedance	Less than 0.3 ohm up to a frequancy of 1 MHz
abilization ratio or ± 10% change in put voltage)	Varies with output voltage (Typically 3000:1) For output voltage in the range 5-50V- Not less than 1500:1 For output voltages in the range 0-5V - Falls towards 1000:1
mperature coefficient output voltage	Less than 0.02% (200 p.p.m.) per ^{o} C.
mperature range	Up to + 40^{o} C. under continuous full load.
mensions	Height. 25.4 cm. (10 in.) Width. 13.9 cm. (5½ in.) Depth. 20.3 cm. (8 in.)
ight	8.6 kgs (19 lbs. 2ozs.) including mains cable.

SECTION 3

OPERATING NOTES

ains cable

Care should be taken when connecting the mains connector lead, upplied with unit, to a suitable mains plug to ensure that the hree leads are each taken to the correct plug pin. In view of the mpending colour coding changes to cables, it is considered orthwhile to list below the two types of colour coding with their onnections:-

Connection	Colour		
Live	Red		Brown
Neutral	Black	or	Blue
Earth	Green		Green/Yellow

ains transformer taps

Prior to switching on the unit ensure that the correct taps on he primary winding of the mains transformer are wired for the part- cular mains voltage in use. Access to the terminal pins to which hese taps are wired is obtained by unscrewing the unit from its ver (four screws at rear) and locating them at the left rear of he unit.

It should be noted that although the nominal mains voltage is, r example 240V, during the greater part of a working day it may be little as 230V. Consequently the taps should be wired with this mind.

tput terminals

The equipment constituting the load which is to be supplied om the unit should be connected to the + and - output terminals th the earth terminal linked to either output terminal as required. a 'floating' supply is desired the earth terminal is left unconnecte te that the only restriction on the use of the unit in this latter ndition is that neither output terminal shall be greater than 500V c. above or below earth potential.

In cases where the voltage drop along the cables connecting e unit to the load is not negligible, the Ampr. + output should be nnected to the + output and the Ampr. - output should be connected the - output, both connections to be made at the load. For a full scription of the correct method of connecting the Ampr. + and Ampr. outputs see Appendix A (Remote Sensing).

ins on-off switch

The mains on-off switch is a toggle switch located on the centre the front panel and is set to the 'on' position by pressing the ver part of the toggle.

dicator lamp

The indicator lamp, which lights to indicate that mains is plied to the unit, is located alongside the manufacturer's name a plate immediately below the meter.

tput voltages

The output voltage of the unit is set by the Output Voltage itch in conjunction with the O-10V control, both of which are located the left hand side of the panel.

ter and Meter switch

The output voltage of the unit is monitored by the meter when the ter switch, located on the right hand side of the panel, is set the Volts position and the upper scale of the meter is then used. en the Meter switch is set to the Amps position the lower scale the meter is used to indicate the current being supplied to the d.

p Current control

The trip Current control, situated on the right hand side of the el, is employed to set the current level at which the overload tection is desired. It should be noted that the extreme clockwise ition of this control is 2.4 indicating that, when the control is in s position, the unit can work satisfactorily at full output rent, and short duration transients can be accommodated without trip function being activated. It should not, however be en to indicate that the unit is intended to operate at load currents ve 2 Amps although in extreme cases, providing that the ambient perature does not rise above 30° C, the unit can be operated isfactorily at a load current of up to 2.4 Amps.

et switch

In order to return the unit to normal operation after the trip functioned, the Reset switch on the centre of the front panel uld be depressed and released.

ies connection

The outputs of two or more units of the same type may be nected in series when a higher output voltage than can be ained from one unit, is desired. It should be noted that, this configuration, no output terminal shall be greater than V d.c. above or below earth potential.

allel Connection

Under no circumstances should the output of one unit be paralleled h the output of another.

ration with pulsed or switched loads

The unit is suitable for use in applications in which the load rent is subject to rapid variations. For a full description of the ration under such conditions see Appendix B.

SECTION 4

TECHNICAL DESCRIPTION

eral

The regulated power supply unit, type TCU-250, is a highly bilized unit consisting of a basic series regulator coupled h a constant current type of overload protection circuit ether with a delayed trip system.

The output voltage can be adjusted to any voltage between and 50V by means of two controls. The first is a five-position tch which selects the output voltage range in 10V steps and second is a potentiometer which enables 'fine' control over articular 10V step. The maximum load current available at any put voltage is 2A. Either output voltage or load current can monitored on the meter, as desired, by the setting of the Meter tch.

Any level of output current within the range of the unit can selected, as the level at which the circuit 'trips', by means the Trip Current control.

NOTE Since certain components on different sub-assemblies in this unit have the same circuit reference numbers, in the detailed description that follows certain prefixes have been allotted to these circuit reference numbers to avoid confusion and enable ready identification. These prefixes only apply to this and the following section of the handbook, unless otherwise stated, and are as follows:-

Sub-assembly	Prefix
Transformer Rectifier assembly	1
Control card (Type A)	2
Heatsink assembly	3
Meter card	4
Main frame	5

Thus 2C1 refers to capacitor C1 on the control card pe A).

nsformer rectifier assembly (Circuit Diagram B.31109)

The transformer rectifier assembly consists of mains transformer located at the bottom of the unit, and a printed circuit board, nted behind the transformer, containing fuse FS1, diodes IMR1-8, capacitors 1C1-1C3 and resistors IR1-IR4.

The primary winding of the mains transformer is linked, via fuse and switch S1 (mains on-off), to the 3-pin plug PL1 to which the main e is connected. The primary winding is tapped at 240, 220, 200, nd 10 volts and the taps are brought out to terminals located on the of the unit at the rear.

There are three secondary windings, the a.c. voltage across the t of which (terminals 4, 5 and 6) is rectified by diodes IMR1 and . The resultant d.c. is smoothed by capacitor IC1 and applied to minals 17 and 18 for onward transmission as the supply for the control sub-assembly.

The a.c. voltage across the second secondary winding (terminals 2 and 3) is rectified by diodes IMR3 and IMR4 and the resultant .. is dropped and smoothed by resistor IRI and capacitor IC2 spectively. The smoothed d.c. output is applied to terminals and 22 for onward feed to transistor 2VT8. Resistor IR2 is a rrent bleed.

The third secondary winding (terminals 11 to 16 inclusive) is pped at four points (terminals 12 to 15) and the output from each these four together with the output from terminal 11 is applied S3a, one bank of switch S3, the Output Voltage switch. Thus om the wiper of this bank one of five voltages can be selected erminal 16 is a common line) and this is applied, via terminal 7, oss capacitor IC3 and then across the bridge rectifier formed diodes IMR5 to IMR8. The resultant unsmoothed d.c. is fed to rminals 19 and 20 for onward transmission to capacitor 5C2 where is smoothed and passed to the series regulator transistors (3VT1 3VT3) in the heatsink assembly. Resistor IR4 is a current bleed.

An output is also taken from terminals 14 and 15 via resistor to lamp LP1 which lights when mains voltage is applied to the unit.

ntrol card, (Type A) (Circuit Diagram B.25607)

The control card is a printed circuit board mounted immediately ind the front panel, in the lower half of the unit. It contains the nstant current overload protection and trip circuitry and the driver ges for the series regulators.

The constant current overload protection circuitry comprises ges 2VT6 and 2VT7 together with driver 2VT5 and amplifier 2VT4. series regulator driver stages are 2VT1 and 2VT8. Stages 2VT2 and T3 make up the trip circuit.

The object of the constant current overload protection circuit to maintain a constant current at the junction of capacitor 2C5 resistor 2R16. This ensures that the base of transistor 2VT5 is held a constant voltage. The operation of the circuit is best described an example.

Assume that the output voltage (the voltage between the + and - put terminals) rises. The current through diode 2MR4 increases sing the emitter of transistor 2VT6 to rise. Through the action zener diode 2ZD4 the potential across resistor 2R19 rises so that base of transistor 2VT7 follows suit causing an increase in the llector current to this latter stage. The base of transistor 2VT6 sequently falls and the emitter of the stage follows thus reducing emitter current and therefore the current through diode 2MR4.

The rise in output voltage, mentioned in the previous paragraph, ses the emitter of transistor 2VT5 to rise and, seeing that the e of this transistor is held constant, the collector current falls sing the base of transistor 2VT4 to rise and this latter transistor ducts more heavily.

The base of transistor 2VT1 consequently falls which, in turn, ses the base of transistor 2VT8 to fall and this, in its turn, ses the bases of transistors 3VT1 and 3VT3 to fall. These two last ges conduct less heavily, their impedance rises and the output tage fall.

Adjustment of the slider of potentiometer 5RV2, the O-10V control the front panel, causes a change in the output voltage which is not nteracted by the action of the circuitry just described. As the der of potentiometer 5RV2 is turned in a clockwise direction more istance is inserted between the negative output terminal and the e of transistor 2VT5 via resistors 5R6, 5R5, 5R4, 5R3 and diode 4. Since it has already been stated that the base of this nsistor is maintained at a constant voltage the effect is to cause increase in output voltage. In like manner the output voltage is ered when, by switching S3, the Output Voltage switch, the wiper bank S3b either inserts into circuit or shorts out any of istors 5R3-5R6. The highest output voltage is obtained when all r resistors just mentioned are in circuit.

Stages 2VT2 and 2VT3 form the trip circuit co ing into operation her if a fault develops on the amplifier section of the control d or if the current being drawn by the load, to which the unit is nected, exceeds the rated maximum. The base potential of transistor 3 is determined by (a) the current flow through resistors 2R5, , 2R9 and potentiometer 2RV1 to the negative supply line (of the trol card) and (b) the current flow through resistor 2R5 and de 2MR1 to the high potential sides of the current sensing resistors, and3R6, via resistors 3R3 and 3R7 respectively.

Under normal operating conditions the potential across the current sing resistors is low enough to keep diode 2MR1 conducting and s the base potential of transistor 2VT3 is such that the transistor i off. Capacitor 2C3 is discharged since no current flows through istor 2R12 and therefore the capacitor has the same (h.t) potential both plates. It can be seen, therefore, that the base-emitter de of transistor 2VT2 is reverse-biased and this transistor is o cut off.

If the current flowing through the current sensing resistors (3R2 3R6) increases to a pre-determined level diode 2MR1 ceases to duct. The base potential of transistor 2VT3 consequently rises and transistor conducts causing its collector to fall and, in doing so, nging diode 2MR2 into conduction. The base of transistor 2VT1 falls, causing the base of transistor 2VT8 to follow suit. The ies regulators (3VT1 and 3VT3) move toward cut-off and the output tage of the unit falls. The current through the current sensing istors is now just sufficient to prevent diode 2MR1 re-conducting so the output current of the unit is maintained at maximum rating. n a constant current, therefore, the output voltage falls in direct portion to the ohmic value of the load.

As transistor 2VT3 comes into conduction, capacitor 2C3 mences to charge so that, through resistor 2R10, the base-emitter de of transistor 2VT2 becomes forward-biased and this transistor ducts. Transistor 2VT3 is now clamped in saturation, by virtue the coupling between its base and 2VT2 collector, and cannot e out of this state until capacitor 2C3 discharges.

When, assuming the conditions existing at the end of the vious paragraph, the Reset switch (s2) is pressed, the lower plate capacitor 2C3 is taken immediately to h.t and transistor 2VT2 s off. Transistor 2VT3 now returns to the cut-off state and the put voltage from the unit returns to the operating level. This, course, presupposes that the fault which caused the excess current been cleared.

The limit current value is 2.4 Amps, or 120% of the maximum rated put current from the unit, and is set up in the following manner. slider of potentiometer 2RV1 is set to its most negative adjustment a low resistance ammeter connected between the unit output terminals. mains voltage is then adjusted to the point where the ammeter icates 2.4 Amps. The slider of potentiometer 2RV1 is then carefully usted until transistor 2VT3 just begins to conduct and initiate the 'trip' action. A this point the current falls rapidly to 2.0 Amps. er Diode 2ZD1, which is connected across potentiometer 2RV1, bilizes the potential difference between the ends of the entiometer,

In order to prevent oscillation of instability, two feedback works are incorporated in the circuit. These are resistor 2R4 and acitor 2C1 between the base of transistor 2VT1 and the negative ply line (of the control card), and resistor 2R15 and capacitor between the base of transistor 2VT4 and the base of transistor 5.

Resistor 2R3 and zener diode 2ZD2 stabilize the supply voltage lied to the major part of the control card circuit at a nominal Diode 2MR3 is a temperature-coefficient compensator for the e-emitter diode of transistor 2VT5, and also acts as a clamp to vent this base-emitter diode from being reverse-biased by more than ut 0.6V. Capacitor 2C5, connected across zener diode 2ZD4 and istor 2R19, filters any noise generated in this zener diode. acitor 2C6, connected across resistors 5R3, 5R4, 5R5, 5R6 and entiometer 5RV2, feeds back into the overload protection circuit voltage variations (i.e. ripple) generated in the output line, thus sing any such variations to be damped.

tsink assembly (Circuit Diagram B.31108)

The heatsink assembly consists of a heatsink on which are mounted two series regulator transistors, 3VT1 and 3VT3, and a printed cuit board containing series resistors 3R3 and 3R7 and current sensing istors 3R2 and 3R6. The assembly is located at the rear top half of unit.

The two series regulator transistors are connected effectively parallel although in the emitter circuit of each is a separate rent sensing resistor. The commoned output from resistors 3R2 and is taken via resistor 5R7 to the + output terminal.

The operation of the series regulator transistors has been cribed in the sub-section dealing with the control card.

er card (Circuit Diagram B.31175)

The meter card is situated immediately behind the meter. nted on the card are potentiometers 4RV1 and 4RV2 together with istors 4R1 and 4R2.

The circuit is used in conjunction with the meter, M1 and the er switch S4. When switch S4 is in the Amps position the meter connected in series with resistor 4R1 and Potentiometer 4RV1 oss resistor 5R7 so that the current through this latter resistor is itored. When switch S4 is in the Volts position the meter is nected in series with resistor 4R2 and potentiometer 4RV2 and this work is then directly across the output terminals of the unit, so t the voltage at these terminals is monitored.

n frame (Circuit Diagram C.25606)

The components not specifically part of any sub-assembly are veniently described as being part of the main frame, Some of se components, (which are prefixed 5) have already been mentioned connection with other circuits but the remainder, and their ction, are detailed here. The phase Main Frame is also used, for rification, as a heading for the Parts List applicable to these ponents.

Capacitor 5C1 which is normally connected to resistor 5R1 via Reset switch (S2), when this is in the rest position, is used to ow capacitor 2C3 to discharge at the commencement of the return ration from 'trip' operation. Resistor 5R1 when reconnected capacitor 5C1, on release of the Reset switch allows this latter acitor to discharge.

Capacitor 5C2 is a reservoir capacitor for the unsmoothed d.c. put from bridge rectifier 1MR5 - 1MR8.

Resistor 5R2 acts as a current bleed while resistor 5R7 acts a shunt for the meter when monitoring current.

Resistors 5R8 and 5R9 are connected between the + and - output Ampr. terminals respectively, and are employed to override the essity of separate connections from the Ampr. outputs during nal usage (i.e. reasonably short lengths of cable between output minals and load) of the unit.

Capacitor 5C3 acts as a final smoothing capacitor and diode protects the unit against high reverse currents or voltages which occur if the unit is accidentally switched off when being used eries with other units.

SECTION 5

MAINTENANCE AND REPAIR

eral

The components and circuit design of this unit are such that rs of satisfactory life may be expected without need for maintenance repair action. Nevertheless component failures can occur and it is sible for accidental damage or misadjustment to arise. The lowing notes are given to cover such contingencies.

icator lamp

If the indicator lamp fails, switch off and withdraw the ufacturer's nameplate from the front panel by raising both ends the nameplate until the lampholder is visible. Carefully turn the pholder through about 90° in a clockwise direction so that it be pulled clear of the slot in the panel. The lamp can then be laced. To refit the lampholder and manufacturer's nameplate in ir correct positions the procedure just outlined should be ersed.

e

If the unit is inoperative when switched on, switch off, unplug mains connecting lead, and remove the unit from its cover by crewing and removing the four screws at the rear. The unit can then pulled forward clear of its cover. The fuse is located at the t hand rear of the unit and is rated at 3A. Replace as necessary.

Anti surge.

lt-finding procedure

If the unit is still inoperative when reconnected to the mains switched on, a step-by-step fault-finding procedure should be ried out.

If, as a result of carrying out the following procedure the lt can be localized to a particular board it is suggested that the rd is returned to the manufacturer for either repair or replacement. the fault cannot be localized or appears to be in a component mounted on a particular board it is suggested that he unit is urned to the manufacturer for repair. The following test equipment necessary for this procedure:-

Multimeter having ranges:-	0-100V a.c., 0-100V d.c. and 0-10A d.c. e.g. Avometer Type 8 or 9.
Load resistor:-	25 ohm 100W.

ess current

Connect the load resistor and multimeter in series across output terminals and set the multimeter to the 10A d.c. range. the Output Voltage switch to the 40 position. Switch on and e the multimeter reading. If this is in excess of 2A and cannot reduced to a level of 2A by pressing the Reset switch, switch off ediately. Disconnect the load resistor and multimeter and return unit to the manufacturer for repair.

If the multimeter reading is of the order of 2A but the dication on the unit meter, with the Meter switch set to the ps position, differs appreciable from this then the fault lies either the meter or meter card.

If the multimeter reading is zero or appreciably less than 2A e fault lies in a part of the circuit which cannot, at this age, be determined. Switch off and disconnect the multimeter. nnect the other end of the load resistor to the now-unconnected tput terminal.

ries regulator supply

Connect the multimeter, set to the 100V d.c. range, across rminals 19 and 20 of the transformer rectifier assembly, with the sitive probe to terminal 19. Maintain the Output Voltage switch t to the 40 position and switch on. The multimeter reading should approx. 62V. If this is correct the fault would apprear to be either the heatsink assembly or the control cards but later checks ll confirm this. If the multimeter reading differs appreciably om 62V connect the multimeter, set to the 100V a.c. range, between rminals 11 and 16 and check that a reading of approx. 50V is tained. If so, the fault would appear to be in the bridge rectifier rcuit (of the transformer rectifier assembly). If a reading of prox 50V is not obtained the fault would appear to be either in the ins transformer or switch S3a.

b-rectifier supply

If the series regulator supply is correct (62V d.c. as measured ross terminals 19 and 20) connect the multimeter set to the 10V a.c. nge, between terminals 1 and 3 and check that a reading of approx. is obtained. If not the mains transformer would appear to be at ult. If the reading can be obtained, set the multimeter to the V, or 30V d.c. range, and connect across terminals 21 and 22 with e positive probe to terminal 21. The reading should be approx. V. If this is so the fault lies either in the auxiliary supply, e control card or the heatsink assembly. If a reading of approx. V is not obtained the fault lies in the rectifier-smoothing circuit R3, 1MR4, 1R1, 1R2, 1C2.

xiliary supply

If the sub-rectifier supply is functioning satisfactorily, nnect the multimeter, set to the 25V or 30V a.c. range, between rminals 4 and 6. Check that a reading of approx. 16V is obtained this cannot be obtained the mains transformer appears to be at ult. If this reading can be obtained set the multimeter to the V d.c. range and connect across terminals 17 and 18 with the itive probe to terminal 17.

Check that a reading of approximately 23V is registered. If the auxiliary supply is correct and the fault lies in either the trol card or heatsink assembly. If this reading is not obtained fault lies in the rectifier and smoothing network 1MR1, 1MR2,

NOTE It is unfortunately not easy to determine, when a fault has been 'tracked down' to either the control card or heatsink assembly, in which of the two sub-assemblies the fault lies without either board substitution or a much more detailed test and it is suggested that in these circumstances the unit is returned to the manufacturer.

tput voltage

If the excess current test is satisfactory but the meter on the it does not register any reading, with the Meter switch set to the its range, on any or all range positions of the Output Voltage itch, the fault lies either in the meter and meter card or the ins transformer or switch S3a. To determine which, connect the ltimeter, set as in the following table, between the points detailed, ting the required Output Voltage switch position as necessary:-

Output Voltage switch position	Multimeter setting	Connected between terminals	Correct reading
—	100V a.c.	12 and 16	40V a.c.
-	100V a.c.	13 and 16	32V a.c.
-	100V a.c.	14 and 16	22V a.c.
-	100V a.c.	15 and 16	14V a.c.
30	100V d.c.	19 and 20 (positive probe to 19)	51V d.c.
20	100V d.c.	" "	41V d.c.
10	100V d.c.	" "	29V d.c.
0	100V d.c.	" "	18V d.c.

If any of the readings obtained during the first four checks ffers appreciably from the third column reading the fault would pear to lie in the mains transformer. If the first four are correct, t one or more of the d.c. readings differs appreciably, switch S3a uld appear faulty. If all eight are correct the meter or meter card uld appear faulty.

APPENDIX A

REMOTE SENSING

As outlined in Section 3, sub-section 'Output terminals', ere the voltage drop along the cables connecting the unit to the ad is not negligible advantage should be taken of the Remote nsing facility.

The need for this facility is much less in a general-purpose wer supply unit than in a unit for a fixed installation, since is usually possible to keep the arrangement and lengths of the nnecting leads such that their voltage drop is insignificant. r this reason, and because it would be a nuisance always to have make separate connections to the Ampr. sockets, the sockets are nked to the output terminals by low-value resistors inside the it. For most normal applications it is possible to use the unit connecting the load to the output terminals and ignoring the pr. sockets, the resulting loss of performance being very minor.

In cases where the output impedance of the power supply is to kept to the minimum, it may be necessary to use the remote sensing thod. If it is only the d.c. resistance which is important the actual yout of the connecting leads will be unimportant but if considerations a.c. impedance and output ripple are important it will be necessary dispose the connecting leads with some care.

If the connecting leads are carelessly disposed (the leads om the Ampr. outputs not run tightly and close to the leads from e output terminals) the following disadvantages may result:

(a) The large loop formed by the high current conductors the load inserts extra inductance in series with the load. If e load current is subject to fast variations this can make the ansient response of the power supply unit appear to be very poor. e importance of this factor is more readily appreciated when it is alized that a change of load current at the rate of one Ampere per crosecond, which is not uncommon, produces an inductive e.m.f. of e Volt in a loop circuit with a self inductance of only one crohenry. The use of the remote sensing connections under such nditions can result in the voltage comparator amplifier being verly overloaded transiently and the overall transient response of e system thus becoming even worse.

(b) The large loop formed by the remote sensing leads can k up considerable electro-magnetic interference from surrounding ay fields, producing abnormally high output ripple or noise.

Within the power supply unit the wiring layout is arranged keep the loop self-inductances to a minimum amd the circuit design is h that the output impedance is low and the transient response very good. The very high perforance which the unit can provide a load connected directly to the output terminals can be degraded reciably by even quite short connecting leads if these are badly posed.

That the performance of the unit depends upon the way in which e connections are made to the load is not a defect in the design the unit. The problem is simply that the power supply unit, the ad and the connections between them are all parts of a high-gain edback loop and, as is well known, there are strict limitations to how far it is possible to correct for deficiencies by the use feedback.

As a general guide to the use of the remote sensing facility e following are recommended limitations:

(a) The total volt drop at maximum load current in the heavy rrent conductors should not exceed 0.5 Volt for the complete op circuit.

(b) The resistance of each of the two remote sensing nnections to the amplifier sockets should be kept as low as ssible, preferably not greater than 0.1 ohm and in extreme cases en lower.

APPENDIX B

OPERATION WITH PULSED OR SWITCHED LOADS

As mentioned in Section 3, sub-section 'Operation with pulsed switched loads', the unit is suitable for use in such applications the following points are worthy of mention.

It is a characteristic of transistors in general that they are rge operated devices, so that it is necessary to inject or tract a certain amount of excess charge in the base circuit in order bring about a change in the collector current. This is the se of the finite 'turn-on', 'storage' and 'turn-off' times quoted transistors when operating in a switching mode. This factor is ticularly relevant to transistorized power supply units when rating under switched or pulsed loading conditions.

The effect is most significant in the power transistor in the ies regulator circuit and gives rise to the following effects:

(a) If the power supply is initially delivering only a small put current and there is a sudden demand for a larger current, even instantaneous change in base current of potential cannot force the er transistors to pass the increased collector current. tantaneously. During the short 'turn-on' period the extra load rent has to be derived from the capacitor across the output minals and there is a consequent transient fall of output voltage.

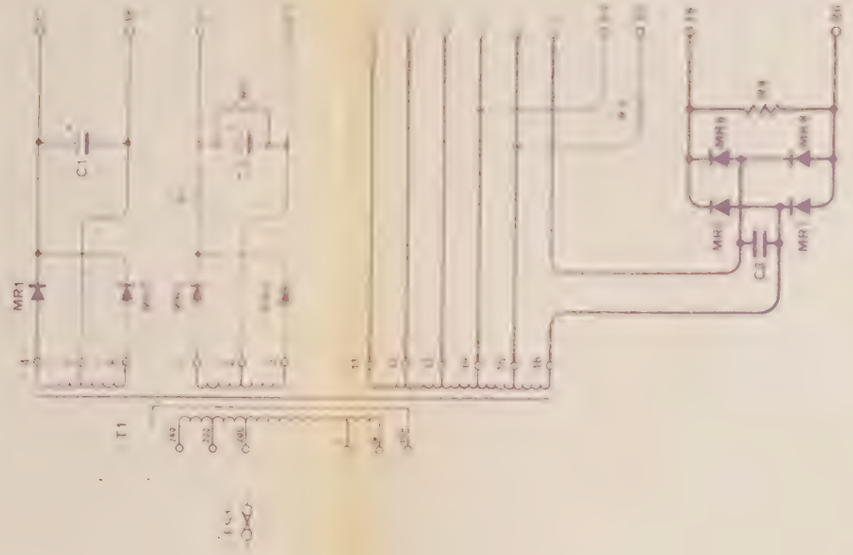
(b) If the power supply is initially delivering a large output rent and there is a sudden reduction in the load current, the series ulator transistors cannot instantaneously be forced to deliver a uced collector current. During the short 'turn-off' period an excess rent is delivered to the output terminals and stored in the shunt acitors, so that there is a transient rise of output voltage.

Effects of the type discussed in the previous para. above depend n the magnitude of the change in load current rather than the ual mean load current level, particularly with regard to (b) of the vious para. For this reason the best possible transient response obtained when the variable part of the load current is only a ll proportion of the total mean load current. If work is being e on a circuit which draws an impulsive load current and freedom m voltage transients is important, it is advisable to put an itional fixed load resistor across the output terminals of the power ply unit such that the peak current drawn from the unit approaches the l load rating of the unit.

When operating into a load circuit which draws current in short ation pulses it is important to remember that the overload tection system may come into action on excessive current even igh the mean current shown on the meter is below the maximum rating he unit. With loads of this nature it is possible for the power ply unit to be heavily overloaded in current peaks without tripping the overload protection system. This will cause no damage but make the power supply unit appear to have poor regulation and nsient response.

If the power supply unit appears to have bad regulation
d to exhibit serious voltage transients when operating into an
pulsive type of load circuit it is necessary to check the magnitude
the peak current being drawn from the supply and to make sure that
e power supply unit is not in fact being overloaded.

THIRD ANGLE PROJECTION · B.S.308



MODEL TCU150
MODEL TCU250

TRANSFORMER - RECTIFIER ASSEMBLY

B31109 Iss 3

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MI 1443	3	4-4-69
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MODIFICATION	ISSUE	DATE

CHECKED

MATERIAL

FINISH

TOLERANCES UNLESS OTHERWISE STATED
FRACTIONAL DIMENSIONS WITHIN ± 1/64"
DECIMAL DIMENSIONS WITHIN ±

DIMENSIONS IN INCHES

SURFACE ROUGHNESS

SCALE

A·P·T ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY, ENGLAND TEL. BYFLEET 41131.

TITLE

DRAWING NUMBER

B31109

CIRCUIT REF.	NAME / REF. No.	VALUE	TOL %	RATING
T1	TRANSFORMER A.P.T. Pt. No. TX 3045			
FS1	FUSE CARTRIDGE. BELLING & LEE L1055/3A APT. Pt.No. "RADIO SPARES." 62310-302	*	ANTI SURGE	3A
R1	RESISTOR W.W. A.P.T. TYPE 'SFM'	4.7	5	½W
R2	RESISTOR METAL OXIDE APT. Pt. No. 23125-331	330	5	½W
R3	RESISTOR CARBON APT. Pt. No. 21121-150	15	10	½W
R4	RESISTOR METAL OXIDE APT. Pt. No. 23125-822	8.2K	5	½W
C1	CAPACITOR ELECT. APT. Pt. No. 11001-507	500uF	+50 -20	30V
C2	CAPACITOR ELECT. APT. Pt. No. 11002-108	1000uF	+50 -20	15V
C3	CAPACITOR POLYESTER. APT. Pt. No. 13111-473/1	0.47uF	10	160V
MR1	RECTIFIER SILICON. APT. Pt. No. 71211-001 (BYX36-150) MULLARD			
MR2	RECTIFIER SILICON APT. Pt. No. 71211-001 (BYX36-150) MULLARD			
MR3	RECTIFIER SILICON APT. Pt. No. 71211-001 (BYX36-150) MULLARD			
MR4	RECTIFIER SILICON APT. Pt. No. 71211-001 (BYX36-150) MULLARD			
MR5	RECTIFIER SILICON APT. Pt. No. 71251-001 (1N4720) MOTOROLA			
MR6	RECTIFIER SILICON APT. Pt. No. 71251-001 (1N4720) MOTOROLA			
MR7	RECTIFIER SILICON APT. Pt. No. 71251-001 (1N4720) MOTOROLA			
MR8	RECTIFIER SILICON APT. Pt. No. 71251-001 (1N4720) MOTOROLA			

MODIFICATION	ISSUE	DATE
	2	16.4.68
ORIGINAL ISSUE	1	8.2.68

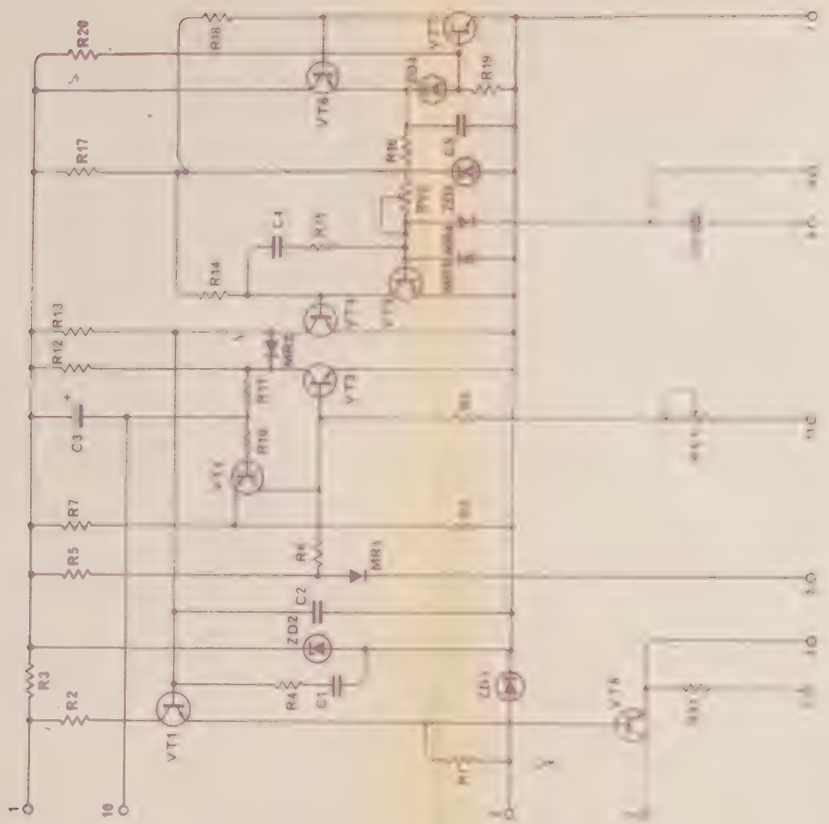
A.P.T. ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY TEL. BYFLEET 41131

TITLE CIRCUIT DIAGRAM
TRANSFORMER RECTIFIER
ASSY. TCU 250 & 150

SHT. No. 1 OF 1 SHTS.

CIRCUIT COMPONENT LIST
CLB31109

THIRD ANGLE PROJECTION B.S.308



MODEL TCU150
MODEL TCU250

CONTROL CARD TYPE A

	2	16-4-68
ORIGINAL ISSUE	1	
MODIFICATION	ISSUE	DATE

MATERIAL

FINISH

TOLERANCES UNLESS OTHERWISE STATED
FRACTIONAL DIMENSIONS WITHIN ± 1/64"
DECIMAL DIMENSIONS WITHIN ±

DIMENSIONS IN INCHES

SURFACE ROUGHNESS

SCALE

A·P·T ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY, ENGLAND TEL. BYFLEET 44101

TITLE

DRAWING NUMBER
B25607

CIRCUIT REF.	NAME / REF. No.	VALUE	TOL %	RATING
R1	RESISTOR METAL OXIDE APT. Pt. No. 23125-472	4.7K	5	½W
R2	RESISTOR METAL OXIDE APT. Pt. No. 23125-102	1K	5	½W
R3	RESISTOR METAL OXIDE APT. Pt. No. 23125-181	180	5	½W
R4	RESISTOR METAL OXIDE APT. Pt. No. 23125-270	27	5	½W
R5	RESISTOR METAL OXIDE APT. Pt. No. 23125-222	2.2K	5	½W
R6	RESISTOR METAL OXIDE APT. Pt. No. 23122-102	1K	2	½W
R7	RESISTOR METAL OXIDE APT. Pt. No. 23125-272	2.7K	5	½W
R8	RESISTOR METAL OXIDE APT. Pt. No. 23125-472	4.7K	5	½W
R9	RESISTOR METAL OXIDE APT. Pt. No. 23125-332	3.3K	5	½W
R10	RESISTOR METAL OXIDE APT. Pt. No. 23125-102	1K	5	½W
R11	RESISTOR METAL OXIDE APT. Pt. No. 23125-223	22K	5	½W
R12	RESISTOR METAL OXIDE APT. Pt. No. 23125-472	4.7K	5	½W
R13	RESISTOR METAL OXIDE APT. Pt. No. 23125-332	3.3K	5	½W
R14	RESISTOR METAL OXIDE APT. Pt. No. 23125-562	5.6K	5	½W
R15	RESISTOR METAL OXIDE APT. Pt. No. 23125-101	100	5	½W
R16	RESISTOR W/W. A.P.T. TYPE SFM	1.05K	2	½W
R17	RESISTOR METAL OXIDE APT. Pt. No. 23125-271	270	5	½W
R18	RESISTOR METAL OXIDE APT. Pt. No. 23125-222	2.2K	5	½W
R19	RESISTOR METAL OXIDE APT. Pt. No. 23125-111	110	5	½W
R20	RESISTOR METAL OXIDE APT. Pt. No. 23125-473	47K	5	½W
R21	RESISTOR METAL OXIDE APT. Pt. No. 23125-822	8.2K	5	½W
R22	OMITTED	-		
R23	OMITTED	-		
RA	OMITTED	-		
RB	OMITTED	-		
RC	OMITTED	LINK		
RD	OMITTED	LINK		

	2	16.4.68			
ORIGINAL ISSUE	1	8.2.68			
MODIFICATION	ISSUE	DATE			

A.P.T. ELECTRONIC INDUSTRIES LIMITED

BYFLEET, SURREY TEL. BYFLEET 41131

TITLE	SHT. No. 1	CIRCUIT COMPONENT LIST
CIRCUIT DIAGRAM CONTROL CARD TYPE 'A' TCU 150 & 250 MODEL	OF 3 SHTS.	CLB25607

CIRCUIT REF.	NAME / REF. No.	VALUE	TOL %	RATING
RE	OMITTED	LINK		
RV1	RESISTOR W/W PRESET APT. Pt. No. 27101-502	5K	10	½W
RV2	RESISTOR W/W PRESET APT. Pt. No. 27101-151	150	10	½W
RV3	OMITTED			
C1	CAPACITOR POLYESTER APT. Pt. No. 13111-473/1	0.047uF	10	160V
C2	CAPACITOR POLYESTER APT. Pt. No. 13112- 472	4700pF	20	400V
C3	CAPACITOR ELECT. MULLARD C426AR/G12.5	12.5uF	-10 +50	25V
C4	CAPACITOR POLYESTER APT. Pt. No. 13111-104/1	0.1uF	10	160V
C5	CAPACITOR POLYESTER APT. Pt. No. 13111-104/1	0.1uF	10	160V
C6	CAPACITOR POLYESTER APT. Pt. No. 13111-474	0.47uF	10	160V
VT1	TRANSISTOR APT. Pt. No. 74221-001 (BC107) MULLARD			
VT2	TRANSISTOR APT. Pt. No. 74211-002 (BCY72) MULLARD			
VT3	TRANSISTOR APT. Pt. No. 74221-002 (BC108) MULLARD			
VT4	TRANSISTOR APT. Pt. No. 74221-002 (BC108) MULLARD			
VT5	TRANSISTOR APT. Pt. No. 74221-002 (BC108) MULLARD			
VT6	TRANSISTOR APT. Pt. No. 74221-002 (BC108) MULLARD			
VT7	TRANSISTOR APT. Pt. No. 74221-002 (BC108) MULLARD			
VT8	TRANSISTOR APT. Pt. No. 74222-002 (BFY52) MULLARD			
MR1	DIODE, SILICON, APT. Pt. No. 71215-001 (SG949A) TRANSITRON			
MR2	DIODE, SILICON, APT. Pt. No. 71215-001 (SG949A) TRANSITRON			
MR3	DIODE, SILICON, APT. Pt. No. 71211-001 (BYX36-150) MULLARD			

MODIFICATION	ISSUE	DATE			
M.I. 1399	4	3.3.69.			
M.I. 1371	3	14.2.69			
	2	16.4.68			
ORIGINAL ISSUE	1	8.2.68			

A.P.T. ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY TEL. BYFLEET 41131

TITLE	SHT. No. 2	CIRCUIT COMPONENT LIST
CIRCUIT DIAGRAM CONTROL CARD TYPE 'A' TCU 150 & 250 MODEL	OF 3 SHTS	CLB25607

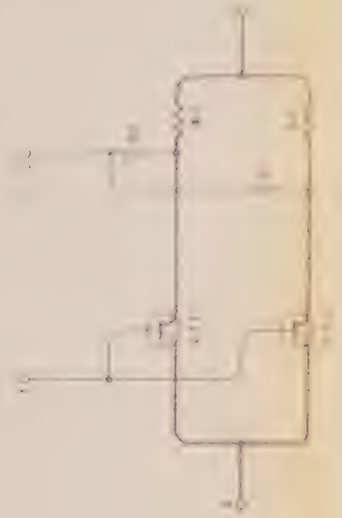
CIRCUIT REF.	NAME / REF. No.	VALUE	TOL %	RATING
MR4	DIODE, SILICON, APT. Pt. No. 71211-001 (BYX36-150) MULLARD			
MR5	OMITTED	-		
MR6	OMITTED	-		
MR7	OMITTED			
ZD1	DIODE, ZENER, APT. Pt. No. 72225-567 (BZY88C5V6) MULLARD	5.6V		
ZD2	DIODE, ZENER, APT. Pt. No. 72235-907 (VR9F) A.E.I.	9.1V		
ZD3	DIODE, ZENER, APT. Pt. No. 72225-757 (BZY88C7V5) MULLARD	7.5V		
ZD4	DIODE, ZENER, APT. Pt. No. 72225-567 (BZY88C5V6) MULLARD	5.6V		

M.I. 1399	2	3.3.69.			
ORIGINAL ISSUE	1	8.2.68			
MODIFICATION	ISSUE	DATE			

A.P.T. ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY TEL. BYFLEET 41131

TITLE	SHT. No. 3	CIRCUIT COMPONENT LIST
CIRCUIT DIAGRAM CONTROL CARD TYPE 'A' TCU150 & 250 MODEL	OF 3 SHTS	CLB25607

THIRD ANGLE PROJECTION B.S.308



MATERIAL	TOLERANCES UNLESS OTHERWISE STATED	A.P.T. ELECTRONIC INDUSTRIES LIMITED	ORIGINAL ISSUE
FINISH	DIMENSIONS IN INCHES	BYFLEET, SURREY, ENGLAND TEL. BYFLEET 4113).	MODIFICATION
	SURFACE ROUGHNESS	TITLE	DRAWING NUMBER
	SCALE		B31108

CIRCUIT REF	NAME / REF. No.	VALUE	TOL %	RATING
R1	OMITTED			
R2	RESISTOR. A.P.T. W.W. BIFILAR	0.5	2	2W
R3	RESISTOR METAL OXIDE APT. Pt. No. 23125-100	10	5	½W
R4	OMITTED			
R5	OMITTED			
R6	RESISTOR. A.P.T. W.W. BIFILAR	0.5.	2	2W
R7	RESISTOR METAL OXIDE APT. Pt. No. 23125-100	10	5	½W
VT1	TRANSISTOR APT. Pt. No. 74225-001 (2N3055)			
VT2	OMITTED			
VT3	TRANSISTOR APT. Pt. No. 74225-001 (2N3055)			

ORIGINAL ISSUE	1	8.2.68			
MODIFICATION	ISSUE	DATE			

A.P.T. ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY
TEL. BYFLEET 41131

TITLE	SHT. No. 1	CIRCUIT COMPONENT LIST
CIRCUIT DIAGRAM HEATSINK ASSEMBLY STCU 250 MODEL	OF 1 SHTS	CLB3108

THIRD ANGLE PROJECTION B.S.308

FIRST USED ON

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MODEL TCU 150
MODEL TCU 250

MASTER CARD

ORIGINAL ISSUE	1	23-7-68
MODIFICATION	ISSUE	DATE

DRAWN

MATERIAL

FINISH

TOLERANCES UNLESS OTHERWISE STATED
FRACTIONAL DIMENSIONS WITHIN ± 1/64"
DECIMAL DIMENSIONS WITHIN ±

DIMENSIONS IN INCHES

SURFACE ROUGHNESS

SCALE

A·P·T ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY, ENGLAND TEL. BYFLEET 41131.

TITLE

DRAWING NUMBER
B31175

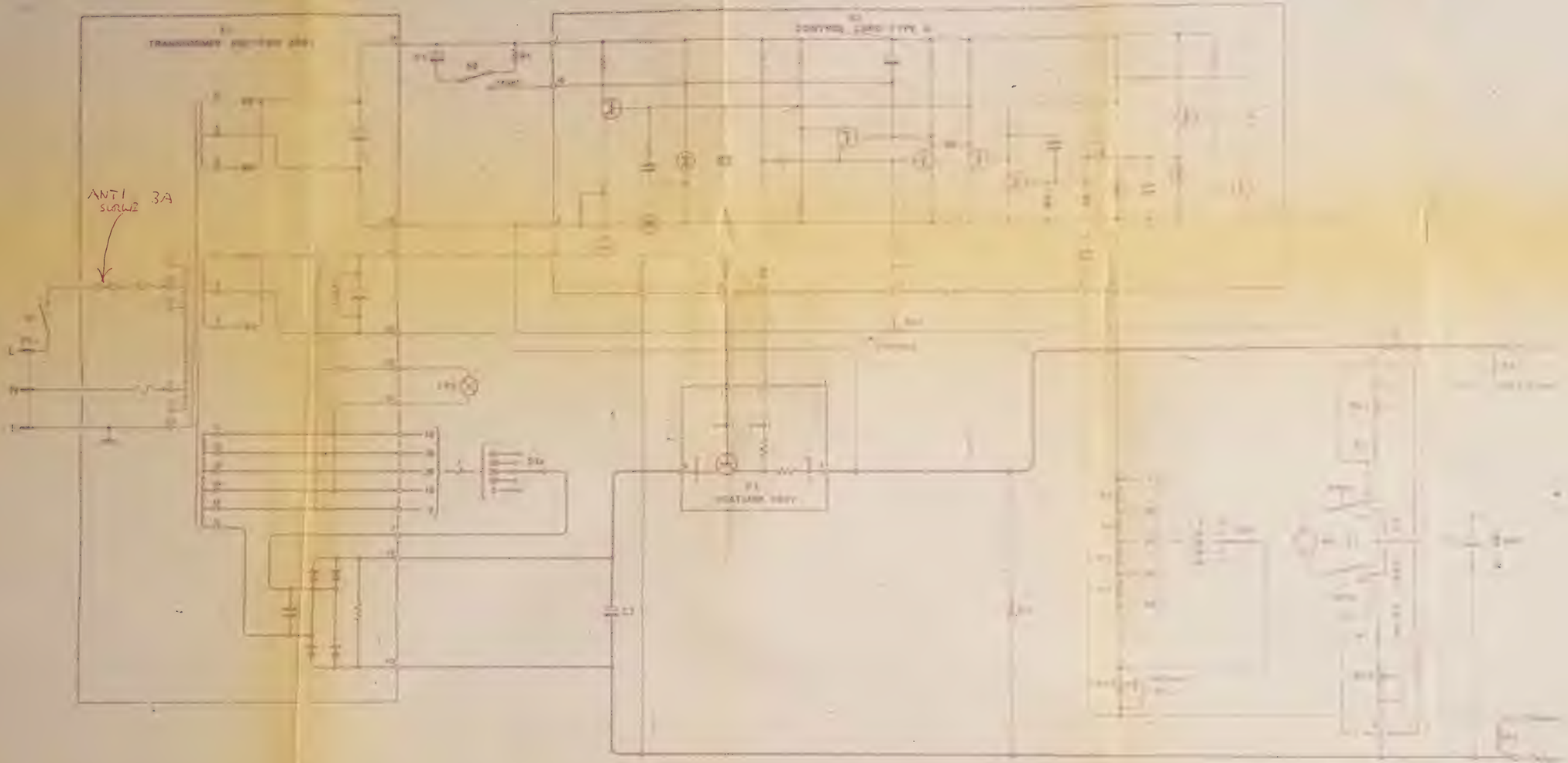
CIRCUIT REF.	NAME / REF. No.	VALUE	TOL %	RATING
R1	RESISTOR METAL OXIDE APT. Pt. No. 23125-331	330	5	½W
R2	RESISTOR METAL OXIDE APT. Pt. No. 23125-473	47K	5	½W
RV1	RESISTOR VARIABLE W.W. APT. Pt. No. 27101-151	150	10	½W
RV2	RESISTOR VARIABLE W.W. APT. Pt. No. 27101-502	5K	10	½W

ORIGINAL ISSUE	1	8.2.68			
MODIFICATION	ISSUE	DATE			

A.P.T. ELECTRONIC INDUSTRIES LIMITED

BYFLEET, SURREY TEL. BYFLEET 41131

TITLE	SHT. No. 1	CIRCUIT COMPONENT LIST
CIRCUIT DIAGRAM METER CARD STCU 250	OF 1 SHTS.	CLB31175


ANTI SURGE 3A

CIRCUIT REF.	NAME / REF. No.	VALUE	TOL %	RATING
X1	TRANSFORMER-RECTIFIER ASSY. CIRC. DIAG. B31109			
X2	CONTROL CARD TYPE 'A' CIRC. DIAG. B25607			
X3	HEATSINK ASSY. CIRC. DIAG. B31108			
X4	METER CARD CIRC. DIAG. B31175			
R1	RESISTOR METAL OXIDE APT. Pt. No. 23125-271	270	5	½W
R2	RESISTOR METAL OXIDE APT. Pt. No. 23125-822	8.2K	5	½W
R3	RESISTOR W.W. A.P.T. TYPE 'SFM'	2K	1	¼W
R4	RESISTOR W.W. A.P.T. TYPE 'SFM'	2K	1	¼W
R5	RESISTOR W.W. A.P.T. TYPE 'SFM'	2K	1	¼W
R6	RESISTOR W.W. A.P.T. TYPE 'SFM'	2K	1	¼W
R7	RESISTOR W.W. A.P.T. TYPE 'ESF'	0.25	1	1W
R8	RESISTOR W.W. A.P.T. TYPE 'SF'	1	5	½W
R9	RESISTOR W.W. A.P.T. TYPE 'SF'	1	5	½W
RV1	RESISTOR VARIABLE W.W. COLVERN CLR3001/95	1K	10	2W
RV2	RESISTOR VARIABLE W.W. COLVERN CLR3001/95	2.5K	10	2W
C1	CAP. ELECT. A.P.T. Pt. No. 11022-106	10uF	-10 +50	64V
C2	CAP. ELECT. A.P.T. Pt. No. 11003-188(2 X 1800uF)	3600uF	-20 +50	85V
C3	CAP. ELECT. A.P.T. Pt. No. 11003-188	1800uF	-20 +50	85V

	2	16.4.68			
ORIGINAL ISSUE	1	6.2.68			
MODIFICATION	ISSUE	DATE			

A.P.T. ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY TEL. BYFLEET 41131

TITLE	SHT. No.1	CIRCUIT COMPONENT LIST
CIRCUIT DIAGRAM POWER SUPPLY UNIT TCU 250	OF 2 SHTS.	CLC25606

IRCUIT REF.	NAME / REF. No.	VALUE	TOL %	RATING
S1	SWITCH 2 POLE ON/OFF M.E.M. GRIDSW. 1613 (I V Y).			
S2	SWITCH PUSH BUTTON C/O BULGIN MP18 (WHITE)			
S3	SWITCH WAFER 2P. 5 POS. A.P.T. DRG. B17590			
S4	SWITCH WAFER 2P. 2 POS. A.P.T. DRG. B18557			
M1	METER, 4" RECTANGULAR A.P.T. DRG. C18556/3			0-50V 0-2A
PL1	PLUG, 3 PIN. BULGIN P429			
LP1	LAMP. SUB. MIN. L.E.S. STELLA No. 65-15	6.5V		1W
MR1	DIODE, APT. PT. NO. 71251-001	(1N4720)		

MODIFICATION	ISSUE	DATE
M.I. 1379	3	19.2.69
	2	16.4.68
ORIGINAL ISSUE	1	8.2.68

A.P.T. ELECTRONIC INDUSTRIES LIMITED
BYFLEET, SURREY TEL. BYFLEET 41131

TITLE	SHT. No.2	CIRCUIT COMPONENT LIST
CIRCUIT DIAGRAM POWER SUPPLY UNIT TCU 250	OF 2 SHTS.	CLC25606